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New geographic records of *Lopesia* Rübsaamen, 1908 (Insecta, Diptera, Cecidomyiidae) in South America

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ABSTRACT

Lopesia (Diptera, Cecidomyiidae) is known from 30 species, 25 Neotropical. All are gall-inducers and monophagous, except *Lopesia davillae.* Each species induces a peculiar gall on the host plant. Due to this specificity, gall morphotype + host plant identification are used to indicate the galler' presence. Most galling-species are known from few localities and the examination of galled exsiccates can add new geographic records. Museu Nacional and Jardim Botânico do Rio de Janeiro herbaria were investigated. 174 exsiccates with galls of seven species of *Lopesia* were found. Several new records are reported (country:1, states: 17, and municipalities: 35).

Keywords: Gall; insect–plant interactions; geographic distribution.

Novos registros geográficos de *Lopesia* Rübsaamen, 1908 (Insecta, Diptera, Cecidomyiidae) na América do Sul

RESUMO

Lopesia (Diptera, Cecidomyiidae) é um gênero conhecido por 30 espécies, 25 delas Neotropical. Todas são indutoras de galhas e monófagas, exceto *Lopesia davillae.* Cada espécie induz uma galha peculiar em sua planta hospedeira. Devido a essa especificidade, o morfotipo de galha + a espécie de planta hospedeira são usados para indicar a presença do galhador. A maioria das espécies indutoras é conhecida de poucas localidades e o exame de exsicatas com galhas pode acrescentar novos registros geográficos. Os herbários do Museu Nacional e do Jardim Botânico do Rio de Janeiro foram vistoriados. Cento e setenta e quatro exsicatas com galhas de sete espécies de *Lopesia* foram encontradas. Novos registros são assinalados (país:1, estados: 17 e municípios: 35).

Palavras-chave: Galha, interação inseto–plantas, distribuição geográfica.

Introduction

Galling insects are amongst the most specialized herbivores because of their ability to control and redirect plant development (SHORTHOUSE et al., 2005). The interaction between host plant and galling insect usually results in a gall morphotype with peculiar shape, size, color, and indumentum (ISAIAS et al., 2013, 2014), which reflects the extended phenotype of the gall-inducing insect (STONE and SCHÖNROGGE, 2003). So, the use of host plant species associated with gall morphology represents a reliable tool that indicates the presence of the gall-inducing species (CARNEIRO et al., 2009).

Information on the geographic distribution of most galling insects is scarce and mostly limited to the localities where species were originally sampled (GAGNÉ and JASCHHOF, 2014). *Lopesia* Rübsaamen, 1908 (Diptera, Cecidomyiidae) is a widely distributed genus of gall midge, with 30 described species, 25 of them from the Neotropics. The other species are Afrotropical (three spp.), Nearctic (one sp.), and Australasian (one sp.) (GAGNÉ and JASCHHOF, 2017; MAIA and MONTEIRO, 2017; GARCIA and URSO-GUIMARÃES, 2019; MAIA, 2019). All species are gall inducers, except *L. davillae* Maia, 2017, whose larva feeds freely on the reproductive structures, mainly the ovaries of developing flowers of *Davilla rugosa* Poir (Dilleniaceae). Most Neotropical species are known from few localities. The exceptions are *L. caulinaris* Maia, 2003, *L. conspicua* Maia, 2003, *L. elliptica* Maia, 2003, and *L. lineares* Maia, 2003, for which there are several records of occurrence. ARRIOLA et al., 2016 extended the distribution of these species based on the examination of exsiccates of their host plant, *Calophyllum brasiliense* Cambess. (Calophyllaceae). The authors used the gall morphology to indicate the presence of the gall-inducing species, showing that herbaria can be excellent sources of geographic records.

The objective of the present study is to contribute to the knowledge on geographic distribution of poorly known Brazilian species of *Lopesia*.

Materials and Methods

A list of Brazilian species of *Lopesia* with their respective host plants was organized based on Gagné & Jaschhof, 2017. Then, the gall morphology was verified in the original descriptions.

From this list, seven species of *Lopesia* were chosen to be investigated - *Lopesia erythroxylii* Rodrigues & Maia, 2010, *L. grandis* Maia, 2001, *L. maricaensis* Rodrigues & Maia, 2010, *L. marginalis* Maia, 2001, *L. similis* Maia, 2004, *L. simplex* Maia, 2002, and *L. tibouchinae* Maia, 2004 - due to their easily recognizable galls.

Results and Discussion

A total of 174 galled exsiccates were found. The geographic limits of all studied gallers were widened. One new country, 17 new state and 35 new municipality records are reported.

For each gall-inducing species the following data are given: host plant species and family, gall morphotype, previous geographic records, number of galled exsiccates, new locality and biome records, other already known locality and biome records, and a map with the current geographic distribution.

Lopesia erythroxyli Rodrigues & Maia, 2010

Host plant: *Erythroxylum ovalifolium* Peyr. (Erythroxylaceae)

Gall: conical bud galls (Figure 1A)

Previous records: RJ – São João da Barra, Parque Nacional da Restinga de Jurubatiba, Carapebus, Arraial do Cabo, Cabo Frio,

Araruama, Saquarema, Maricá, Grumari (in Rio de Janeiro City), and Ilha Grande (in Angra dos Reis City) (Atlantic Forest, restinga); ES – Santa Teresa (Atlantic Forest, Ombrophilous Forest). Refs.: MONTEIRO et al., 1994; MAIA, 2001; MONTEIRO et al., 2004; OLIVEIRA and MAIA, 2005; MAIA and OLIVEIRA, 2010; RODRIGUES and MAIA, 2010; MAIA et al., 2014; CARVALHO-FERNANDES et al., 2016.

Herbarium data: RB –15 exsiccates with galls.

New state record: SP – Itanhaém (Atlantic Forest).

New municipality record: RJ – Mangaratiba (Atlantic Forest, restinga).

Other records (already known): RJ – Carapebus, Cabo Frio, Saquarema, Maricá, and Grumari (in Rio de Janeiro City) (Atlantic Forest, restinga).

Current distribution is showed in Figure 1B.

1A

1B

Figure 1. *Lopesia erythroxyli* Rodrigues & Maia, 2010 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful area) and that of the galler (green circles). / **Figura 1.** *Lopesia erythroxyli* Rodrigues & Maia, 2010 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (área colorida) e do galhador (círculos verdes).

Lopesia grandis Maia, 2001

Host plant: *Dalbergia ecastophyllum* L. Taub. (Fabaceae)

Gall: discoid leaf galls (Figure 2)

Previous records: RJ – Ilha Grande (in Angra dos Reis City), Parque Nacional da Restinga de Jurubatiba, Camboinhas (in Niterói City), Parque Ecológico Chico Mendes (in Rio de Janeiro City), Araruama, and Arraial do Cabo (Atlantic Forest, restinga); SP – Bertioga (Atlantic Forest, restinga); BA – Porto Seguro (Atlantic Forest, restinga). Refs.: MAIA, 2001; MONTEIRO et al., 2004; OLIVEIRA and MAIA, 2005; MAIA et al., 2008; MAIA and BARROS, 2009; MAIA, 2015; CARVALHO-FERNANDES et al., 2016.

Herbarium data: RB – 26 exsiccates with galls.

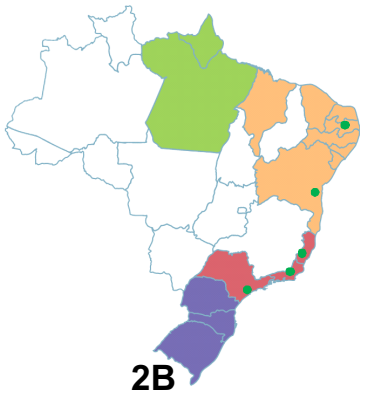
New state records: PB – Mataraca (Atlantic Forest, riparian forest); ES – Conceição da Barra (Atlantic Forest, restinga), Praia das Neves (in Presidente Kennedy City) (Atlantic Forest, restinga), Aracruz, Estação Biológica da Marinha Mello Leitão (Atlantic Forest, beach), and São Mateus (Atlantic Forest, restinga).

New municipality records: BA – Santa Cruz de Cabrália (Atlantic Forest, restinga and riparian forest), Camamu (Atlantic Forest, restinga), Itacaré (Atlantic Forest, rainforest), Nova Viçosa (Atlantic Forest, riparian forest), Una (Atlantic Forest, restinga), Ilhéus (Atlantic Forest), Valença (Atlantic Forest, dense ombrophilous forest), and Belmonte (Atlantic Forest, restinga; RJ – São Francisco de Itabapoana (Atlantic Forest, restinga), Ilha da Marambaia (in Mangaratiba City) (Atlantic Forest, restinga), and Paraty (in Área de Proteção Ambiental de Cairuçu (Atlantic Forest); SP – Ubatuba (Atlantic Forest, beach) and Ilha do Cardoso (in Cananéia City) (Atlantic Forest, restinga).

Other records (already known): RJ – Arraial do Cabo (Atlantic Forest, restinga) and Ilha Grande (in Angra dos Reis City) (Atlantic Forest, restinga).

Current distribution in showed in Figura 2b.

2A



2B

Figure 2. *Lopesia grandis* Maia, 2001 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful areas: green = North Region, orange = Northeast Region, red = Southeast Region, blue = South Region) and that of the galler (green circles). / **Figura 2.** *Lopesia grandis* Maia, 2001 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (áreas coloridas: verde = Região Norte, laranja = Região Nordeste, vermelho = Região Sudeste, azul = Região Sul) e do galhador (círculos verdes).

Lopesia marginalis Maia, 2001

Host plant: *Couepia ovalifolia* (Schott) Benth (Chrysobalanaceae)

Gall: marginal leaf rolls (Figura 3A).

Previous records: RJ – São João da Barra (Atlantic Forest, restinga), Arraial do Cabo (Atlantic Forest, restinga), Saquarema (Atlantic Forest, restinga), and Maricá (Atlantic Forest, restinga). Refs.: MAIA, 2001 and CARVALHO-FERNANDES et al., 2016.

Herbarium data: RB – 26 exsiccates with galls.

New state records: BA – Caravelas (Atlantic Forest, restinga) and Conde (Atlantic Forest); ES – São Mateus (Atlantic Forest, restinga), Linhares (Reserva Natural Vale do Rio Doce) (Atlantic Forest), Itaguaçu (Atlantic Forest, Ombrophilous Forest), and Alto Limoeiro (in Itarana City) (Atlantic Forest).

New municipality records: RJ – Cabo Frio (Atlantic Forest, restinga), Araruama (Atlantic Forest, restinga), and Rio de Janeiro (Atlantic Forest, restinga).

Other records (already known): RJ – Arraial do Cabo (Atlantic Forest, restinga) and Saquarema (Atlantic Forest, restinga).

Herbarium data: R – 16 exsiccates with galls.

New municipality records: RJ – Cabo Frio (Atlantic Forest, restinga) and Rio de Janeiro (Atlantic Forest, restinga).

Other records (already known): RJ – Arraial do Cabo (Atlantic Forest, restinga) and Maricá (Atlantic Forest, restinga).

Current distribution is showed in Figure 3B.

3A

3B

Figure 3. *Lopesia marginalis* Maia, 2001 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful areas: orange = Northeast Region, red = Southeast Region) and that of the galler (green circles). / **Figura 3.** *Lopesia marginalis* Maia, 2001 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (áreas coloridas: laranja = Região Nordeste, vermelho = Região Sudeste) e do galhador (círculos verdes).

Lopesia maricaensis Rodrigues & Maia, 2010

Host plant: *Protium brasiliense* (Spr.) Engl. (Burseraceae)

Gall: marginal leaf rolls (Figure 4A).

Previous records: RJ – Maricá (Atlantic Forest, restinga) and Mangaratiba (Atlantic Forest, restinga). Refs.: RODRIGUES and MAIA, 2010 and RODRIGUES et al., 2014.

Herbarium data: R – 12 exsiccates with galls.

New country record: Peru – Iquitos (Amazon Forest – new record of biome).

New municipality records: RJ – Carapebus (Atlantic Forest, restinga) and Rio de Janeiro (Atlantic Forest, restinga).

Other record (already known): RJ – Maricá (Atlantic Forest, restinga).

Herbarium data: RB – 17 exsiccates with galls.

New state records: PB – Caaporã (Atlantic Forest); MG – Diamantina (Cerrado – new record of biome), Lagoa Santa (Cerrado – new record of biome), Serra do Cipó (Cerrado – new record of biome), Santa Rita do Riacho (Cerrado – new record of biome), and Jaboticatubas (Cerrado – new record of biome).

New municipality records: RJ – Cabo Frio (Atlantic Forest, restinga), Carapebus (Atlantic Forest, restinga), Casimiro de Abreu (Atlantic Forest), Niterói (Atlantic Forest), and Rio de Janeiro (Atlantic Forest, restinga).

Current distribution is showed in Figure 4B.

4A

4B

Figure 4. *Lopesia maricaensis* Rodrigues & Maia, 2010 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful areas: yellow = Midwest Region, orange = Northeast Region, red = Southeast Region) and that of the galler (green circles). / **Figura 4.** *Lopesia maricaensis* Rodrigues & Maia, 2010 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (áreas coloridas: amarelo = Região Centro-Oeste, laranja = Região Nordeste, vermelho = Região Sudeste) e do galhador (círculos verdes).

Lopesia similis Maia, 2004

Host plant: *Protium heptaphylum* (Aubl.) Marchand (Burseraceae)

Gall: marginal leaf rolls (Figure 5A).

Previous records: PE – Tamandaré and Recife (Atlantic Forest); GO – no municipality data (Cerrado); MS – Aquidauana (Cerrado); MG – Serra de São José (Cerrado), Itamonte (Atlantic Forest), and São Tomé das Letras (Atlantic Forest); ES – Guarapari (Atlantic Forest, restinga); RJ – São João da Barra (Atlantic Forest, restinga), Carapebus (Atlantic Forest, restinga), Arraial do Cabo (Atlantic Forest, restinga), Araruama (Atlantic Forest, restinga), Rio de Janeiro (Atlantic Forest, restinga), and Maricá (Atlantic Forest, restinga). Refs.: MAIA and FERNANDES, 2004; NARAHARA et al., 2004; BREGONCI et al., 2010; SANTOS et al., 2012; MAIA, 2013, 2014; ASCENDINO and MAIA, 2014; ARAÚJO et al., 2015; CARVALHO-FERNANDES et al., 2016.

Herbarium data: RB – 23 exsiccates with galls.

New state records: PA – Serra do Cachimbo (Amazon Forest – new record of biome) and Ponta da Pedra (in Alter do Chão, Santarém) (Amazon Forest – new record of biome); PB – João Pessoa (Atlantic Forest); DF – Brasília (Cerrado), AL – Maceió (Atlantic Forest); SE – Itaporanga d'Ajuda (Atlantic Forest); MT – Cocalinho (Cerrado); BA – Conde (Atlantic Forest) and Porto Seguro (Atlantic Forest).

New municipality records: MG – Perdizes (Cerrado); ES – Vila Velha (Atlantic Forest).

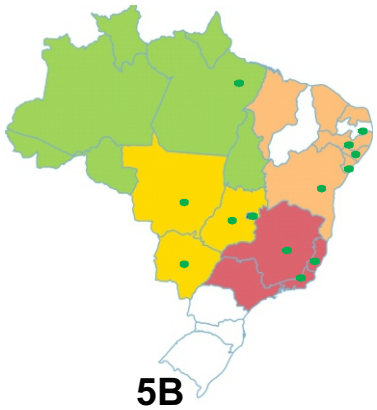
Herbarium data: B – 12 exsiccates with galls.

New municipality records: RJ – Quissamã (Atlantic Forest, restinga) and Macaé (Atlantic Forest, restinga).

Other record (already known): RJ – Carapebus (Atlantic Forest, restinga).

Current distribution is showed in Figure 5B.

5A



5B

Figure 5. *Lopesia similis* Maia, 2004 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful areas: green= North Region, orange = Northeast Region, yellow = Midwest Region, red = Southeast Region) and that of the galler (green circles). / **Figura 5.** *Lopesia similis* Maia, 2004 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (áreas coloridas: verde = Região Norte, laranja = Região Nordeste, amarelo = Região Centro-Oeste, vermelho = Região Sudeste) e do galhador (círculos verdes).

Lopesia simplex Maia, 2002

Host plant: *Protium icicariba* (DC.) March (Burseraceae)

Gall: marginal leaf rolls (Figure 6A).

Previous records: RJ – Carapebus (Atlantic Forest, restinga) and Mangaratiba (Atlantic Forest, restinga). Refs.: MAIA et al., 2002 and RODRIGUES et al., 2014.

Herbarium data: R – 14 exsiccates with galls.

New state record: MG – Belo Horizonte (Cerrado – new record of biome) and Ouro Preto (Parque Estadual do Itacolomi) (Atlantic Forest – Cerrado transition).

New municipality records: RJ – Maricá (Atlantic Forest, restinga) and Rio de Janeiro (Atlantic Forest, restinga).

Other record (already known): RJ – Carapebus (Atlantic Forest, restinga).

Herbarium data: RB – 11 exsiccates with galls.

New state record: ES – Vila Velha (Atlantic Forest).

New municipality records: RJ – Arraial do Cabo (Atlantic Forest, restinga), Quissamã (Atlantic Forest, restinga), and Rio de Janeiro (Atlantic Forest, restinga).

Current distribution is showed in Figure 6B.

6A

6B

Figure 6. *Lopesia simplex* Maia, 2002 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful areas: orange = Northeast Region, red = Southeast Region) and that of the galler (green circles). / **Figura 6.** *Lopesia simplex* Maia, 2002 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (áreas coloridas: laranja = Região Nordeste, vermelho = Região Sudeste) e do galhador (círculos verdes).

Lopesia tibouchinae Maia, 2004

Host Plant: *Pleroma candolleanum* (Mart. ex DC.) Triana (=*Tibouchina candolleana* (DC.) Cogn. (Melastomataceae)

Gall: leaf vein and petiole swellings (Figure 7A).

Previous record: MG – Tiradentes (Cerrado). Ref.: MAIA and FERNANDES, 2004.

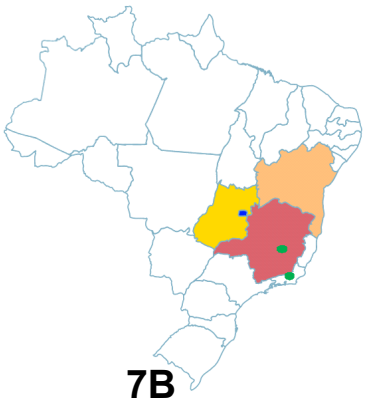
Herbarium data: RB –2 exsiccates with galls.

New state record: RJ – Santa Maria Madalena (Parque Estadual do Desengano) (Atlantic Forest – new record of biome).

New municipality record: MG – Patrocínio (Cerrado).

Current distribution is showed in Figure 7B.

7A



7B

Figure 7. *Lopesia tibouchinae* Maia, 2004 (Diptera, Cecidomyiidae). **(A)** Gall; **(B)** Brazil map showing the current distribution of the host plant (colorful areas: orange = Northeast Region, ryellow = Midwest Region, red = Southeast Region) and that of the galler (green circles). **Figura 7.** *Lopesia tibouchinae* Maia, 2004 (Diptera, Cecidomyiidae). **(A)** Galha; **(B)** Mapa do Brasil mostrando a distribuição geográfica atual da planta hospedeira (áreas coloridas: laranja = Região Nordeste, amarelo = Região Centro-Oeste, vermelho = Região Sudeste) e do galhador (círculos verdes).

Lopesia maricaensis and *L. similis* showed the widest geographic distribution, the former from Peru to Brazilian Southeast Region and the latter from Brazilian North Region to Southeast Region. Both species occur in three biomes: Amazon Forest, Cerrado and Atlantic Forest. *Lopesia grandis* and *L. marginalis* are distributed in the Northeast and Southeast regions, but exclusively in areas of Atlantic Forest. The other species, *L. erythroxyli*, *L. simplex* and *L. tibouchinae* are restricted to the Southeast Region, at least until this moment, the first with records only in Atlantic Forest and the last two occurring in Atlantic Forest and Cerrado.

Comparing the distribution of the gall-inducing species with that of the host plant species, we can verify that the distribution area of all plants is wider than that of their gallers, indicating that the latter can have a wider distribution than the known. The only exception was *Erythroxylum ovalifolium* whose occurrence area is restricted to Rio de Janeiro state, according to FLORA DO BRASIL (2020), but in the herbarium of Jardim Botânico do Rio de Janeiro, one exsiccate from São Paulo was found. Other inconsistencies in relation to plant distribution were observed. Exsiccates of *Protium brasiliense* and *P. heptaphyllum* from Paraíba, *P. icicariba* from Minas Gerais, and *Pleroma candolleanum* from Rio de Janeiro were found in the herbarium, but the known distribution area of these species does not include these states, indicating new locality records or a misidentification of the host plants.

Conclusion

The geographic distribution of *Lopesia erythroxylii*, *L. grandis*, *L. maricaensis*, *L. marginalis*, *L. similis*, *L. simplex*, and *L. tibouchinae* was extended based on herbaria data.

Since the distribution area of all host plant species is wider than that of their gallers, the latter can have a wider distribution than the current known.

The great amount of new records reinforce the herbarium importance as source of information.

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